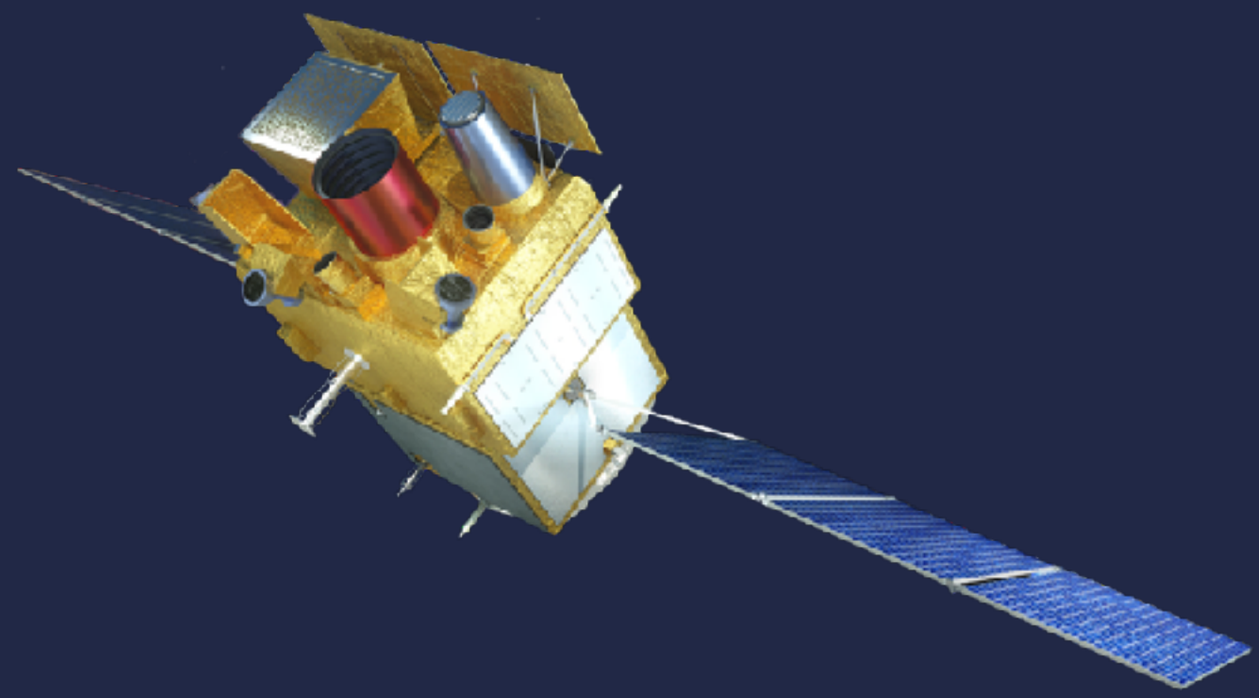
Visible Telescope for dummies



A general overview of the VT characteristics and performances for SVOM

Jesse T. Palmerio

09/05/2023 - LIA COLIBRI meeting - Fréjus, France

The SVOM mission

Space
Variable
Object
Monitor

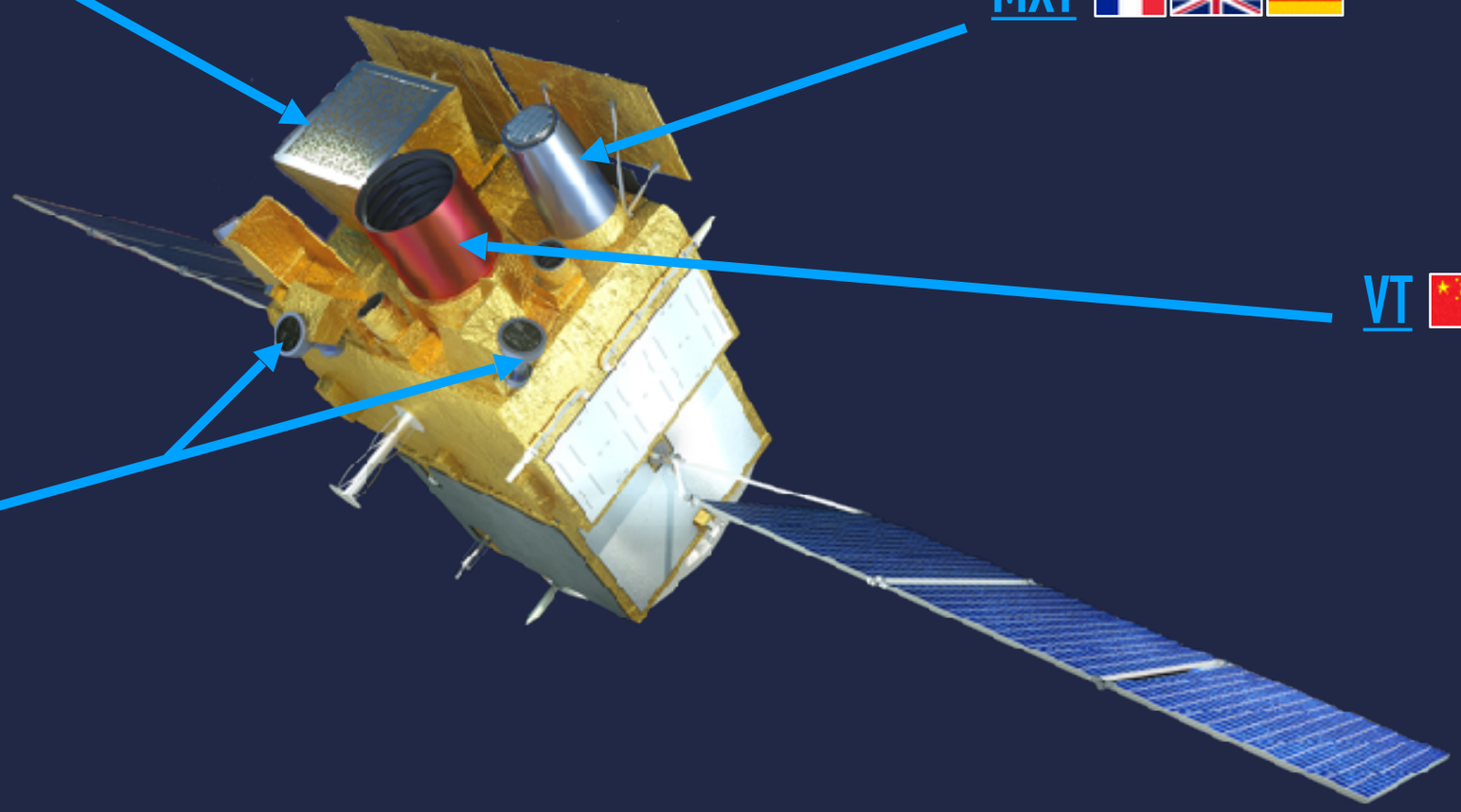
SPACE

ECLAIRS

MXT

VT

GRM



GROUND

GWAC

C-GFT

F-GFT (COLIBRI)

VT purpose

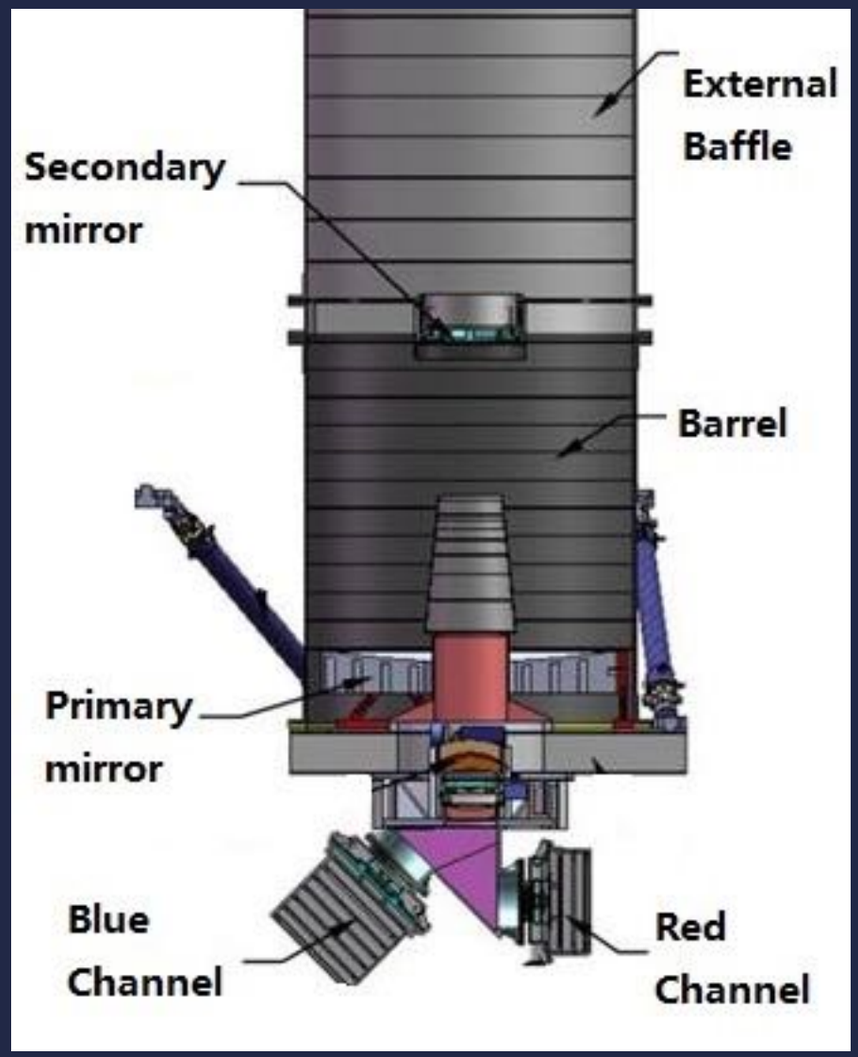
Visible Telescope

- **Rapidly identify** optical afterglow of GRBs detected by SVOM
- Provide **arcsecond localization** of candidate afterglow
- **Early optical/NIR information** (temporal evolution, extinguished GRBs, high redshift…)
- Crucial step to **allow for further ground-based follow-up** such as **spectroscopy** (for redshift)

VT characteristics

Visible Telescope

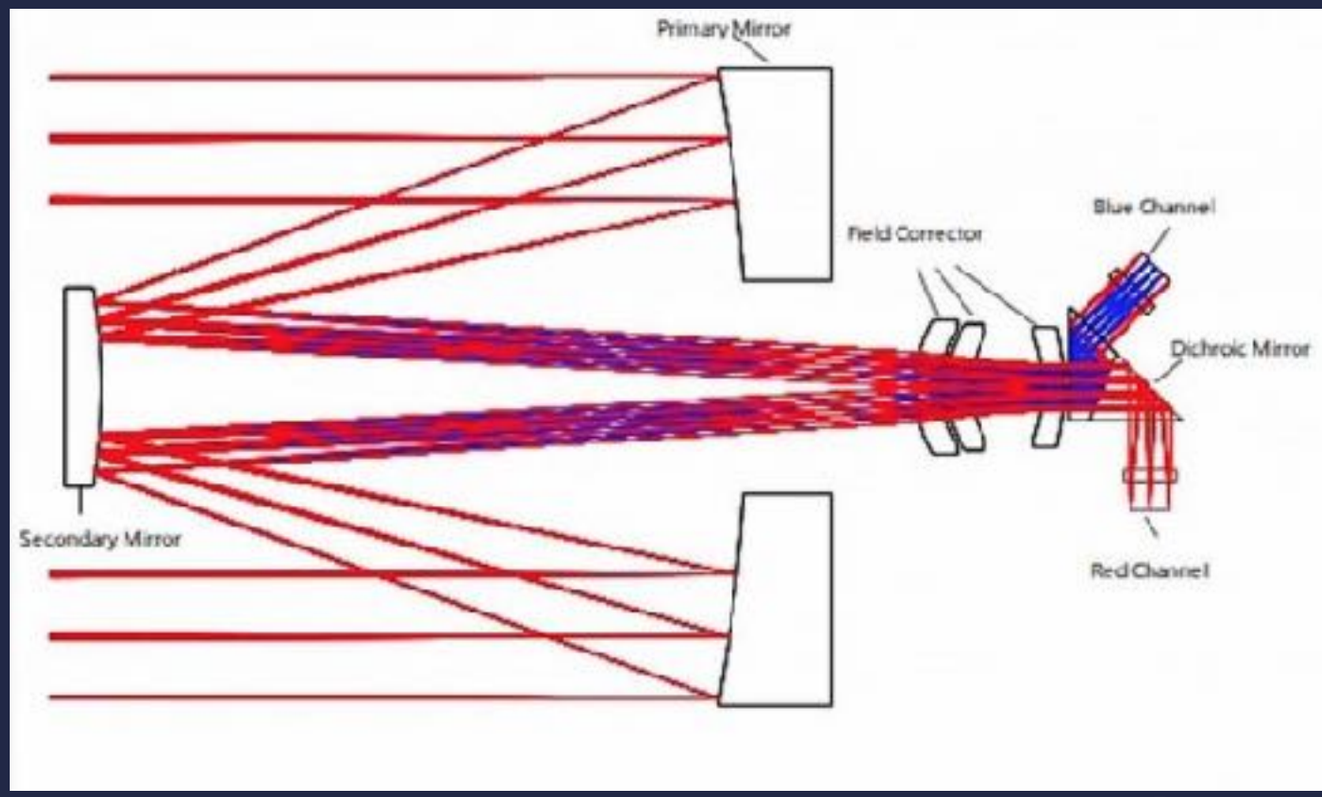
- Ritchey-Chretien telescope
- Aperture: 440 mm
- Magnitude limit in V : ~22.5 after 300s
- Field of View : ~ 26’ x 26’
- RON: < 6e-/pix (rms) in 100s

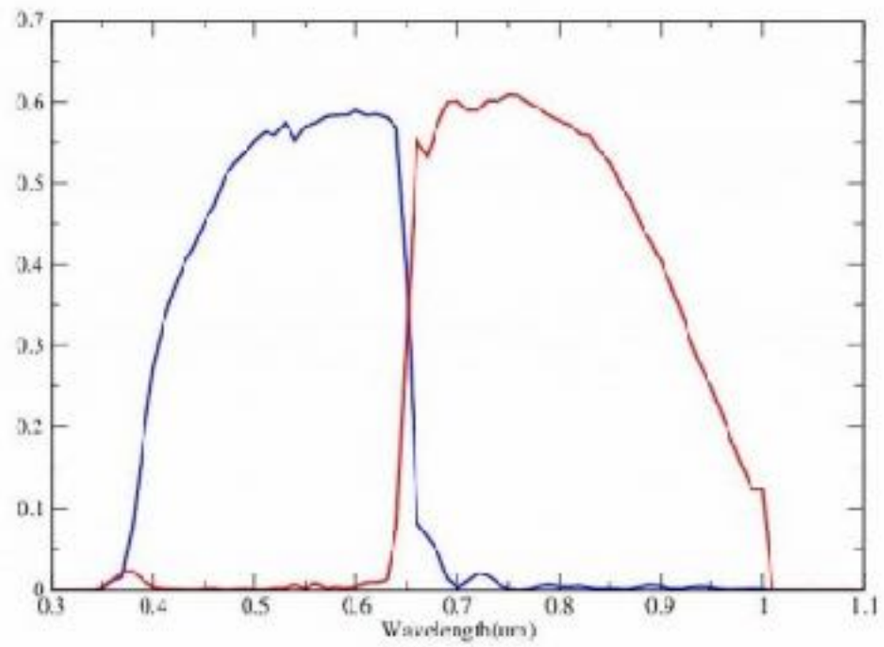


VT characteristics

Visible Telescope

- Two **simultaneous** channels split by a dichroic:
  - Blue channel:
    - 4000 to 6500 Å
    - 2K×2K normal back-illuminated CCD detector
    - PSF: 2.9” (diameter of 80% energy)
  - Red channel:
    - 6500 Å to 1 μm
    - 2K×2K deep-depleted CCD detector for sensitivity at longer wavelengths
    - PSF: 1.9” (diameter of 70% energy)

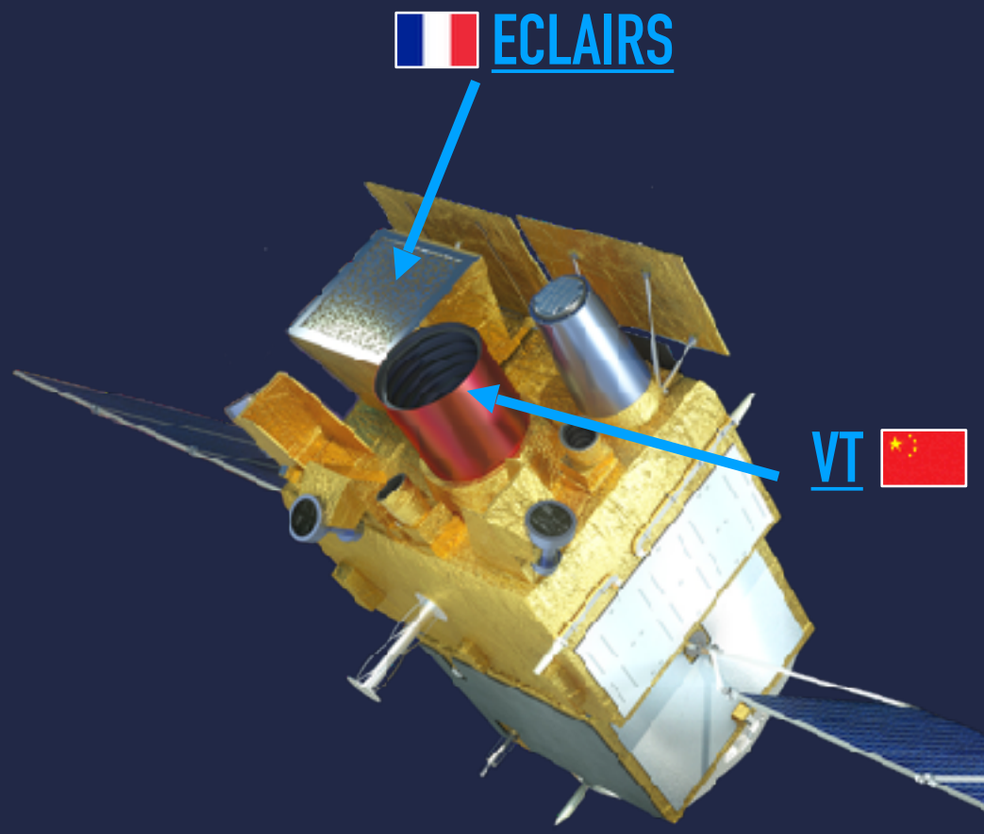




VT design for GRBs

Visible Telescope

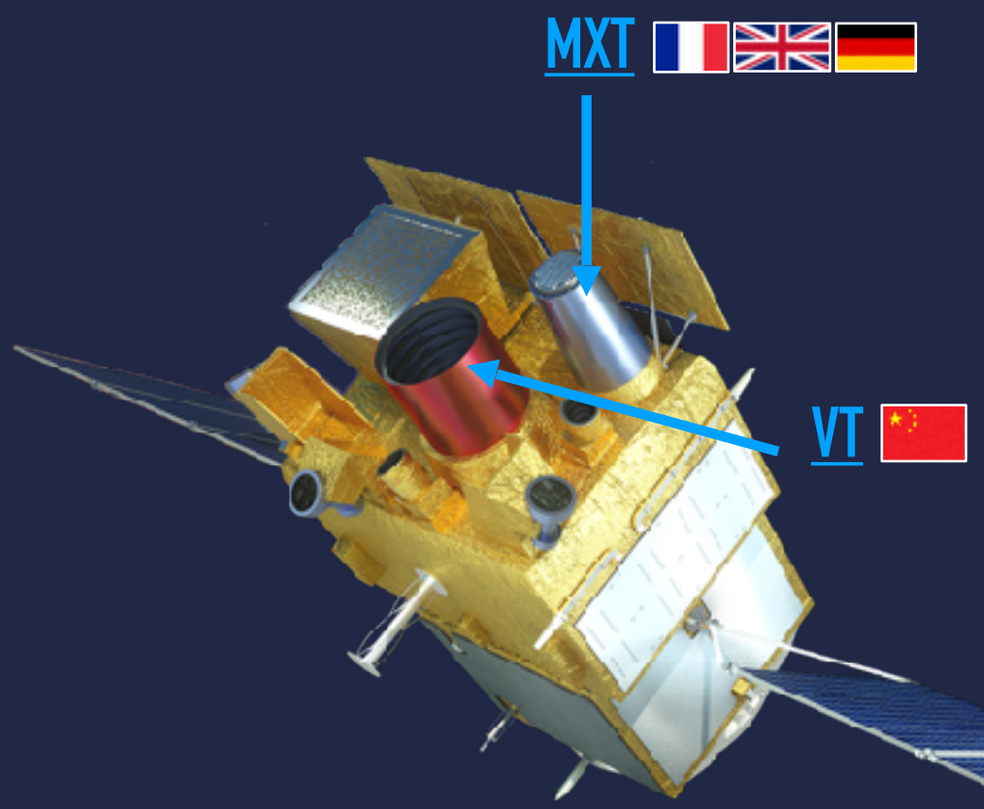
- **VT FoV** covers **ECLAIRs error region**



VT design for GRBs

Visible Telescope

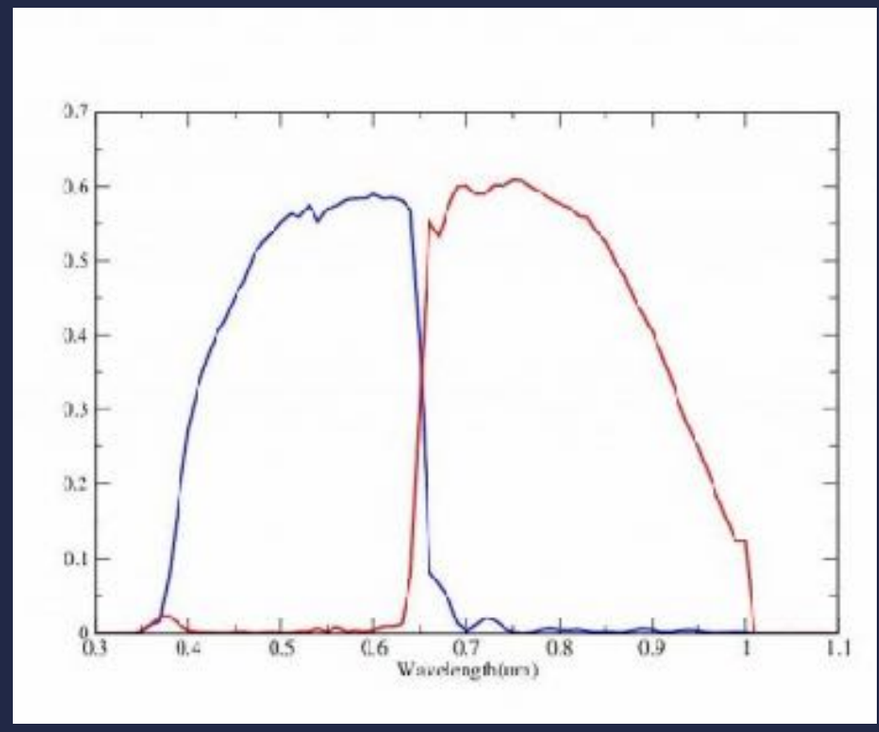
- **VT FoV** covers **ECLAIRs error region**
- VT **co-aligned** with MXT -> cross calibration for improved MXT accuracy



VT design for GRBs

Visible Telescope

- **VT FoV** covers **ECLAIRs error region**
- VT **co-aligned** with MXT -> cross calibration for improved MXT accuracy
- Red and Blue channels for early hints of **high-z** or **dusty** GRBs
- Red channel extends to 1 μm for **high-z** GRBs



VT observing sequence

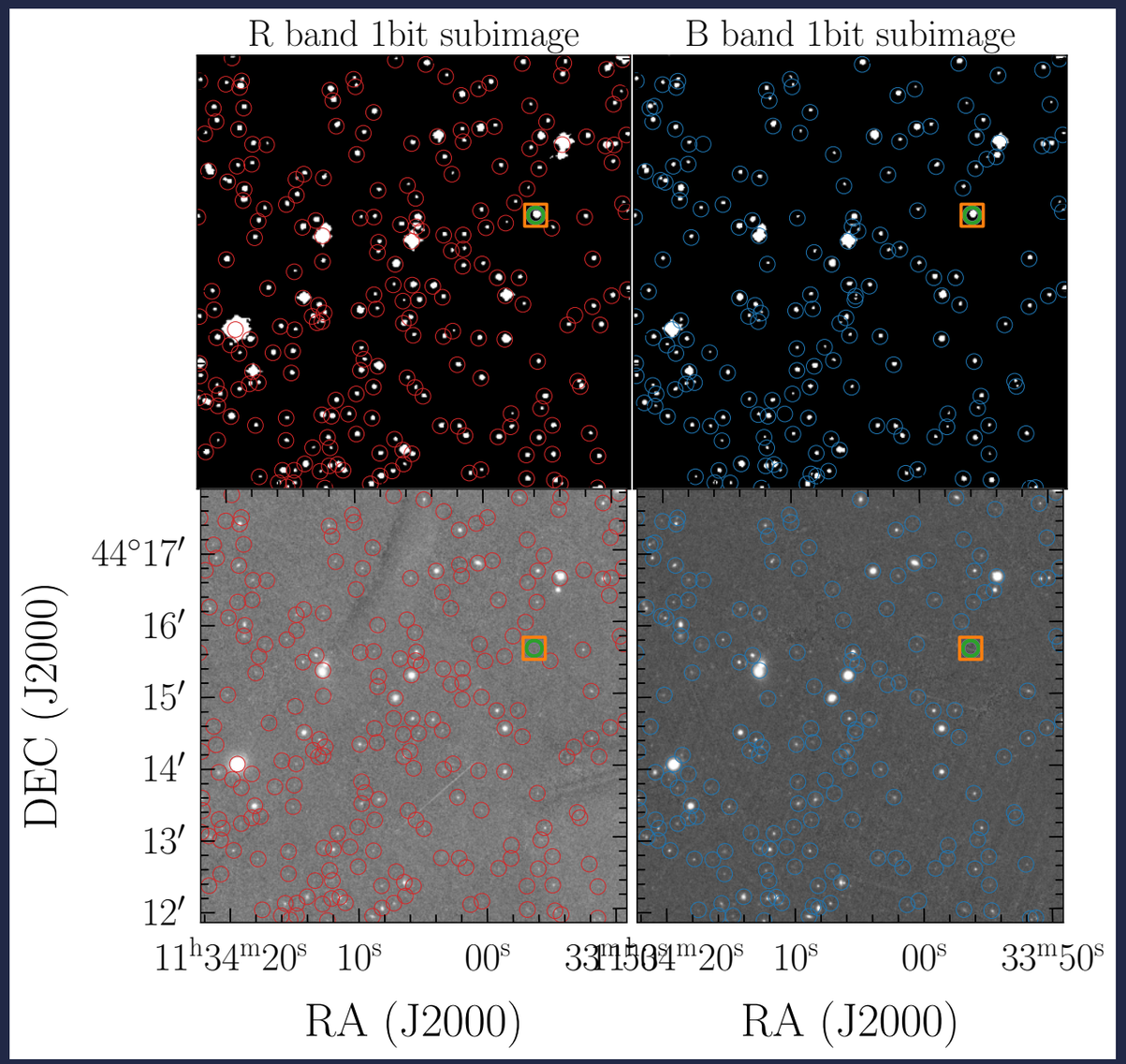
Visible Telescope

- **Core Program** (up to 4 sequences after a GRB detection):
  - 1st sequence: short **5 min** exposition (3 x 100s combined into one image)
  - 2nd-4th sequence: deeper **10 min** image
- Basic on-board processing on 6’ x 6’ arcmin subimage, centered on MXT position if available
- Specific data is **downlinked** in near **real time** to Earth via **VHF network** (low bandwidth) and covered by Beidou redundancy in case of VHF failure
- VHF data include **1bit subimage** and **list of detected sources** which are processed immediately to disseminate information to wider community

VT afterglow identification

Visible Telescope

- **Multiple modules** running in **real time** at French Science Center (FSC) which processes VT VHF data as it arrives
- Algorithm identifies afterglow candidates:
  - **New sources** not in catalogs
  - Existing sources having **varied**
  - Within/close to **MXT position**



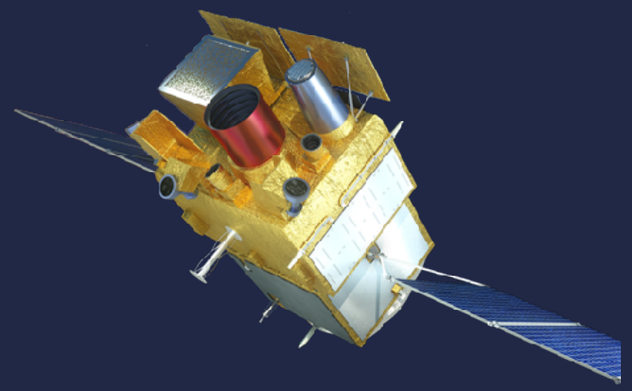
VT status

Visible Telescope

- Some issues that caused some delays are now solved:
  - PSF is stable to 1% thanks to new thermo design
  - Ghost images have been greatly reduced thanks to software solutions and a physical mask for blocking stray light

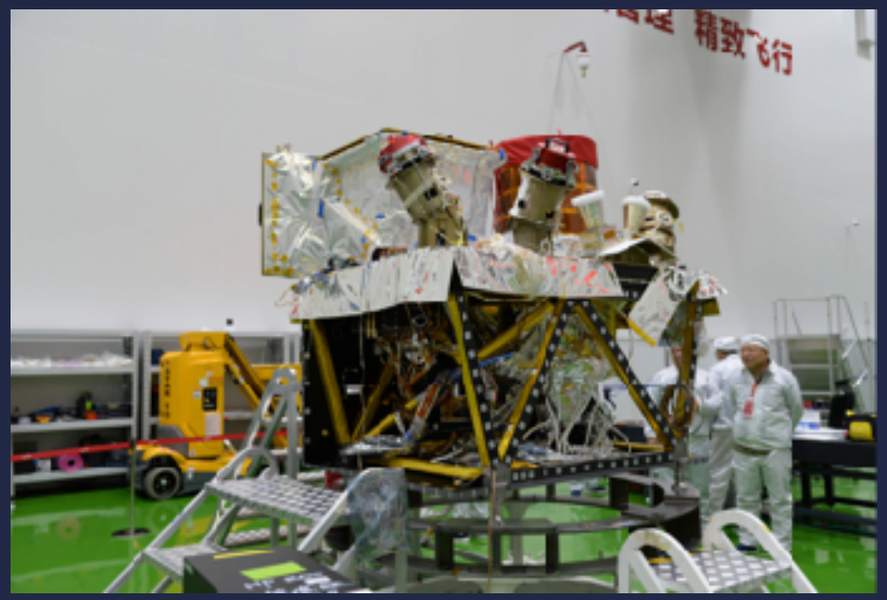
VT at SCEM for testing.
Credit: Yulei QIU

Summary



Space
Variable
Object
Monitor

- VT is onboard Visible Telescope of SVOM
- It is key to get an early optical detection and localize the GRB afterglow enabling the use of GRBs as probes of the Universe
- Designed for optimal follow-up of GRBs detected by ECLAIRs, in particular high-z and dusty GRBs thanks to two bands, extending up to 1 micron
- Though some unforeseen issues led to some delays, solutions were found
- Already integrated on flight model in Shanghai!



SVOM flight model
Credit: Stéphane Schanne